Stepping out of Planned Obsolescence into the Circular Economy

the emergence, effects, and ethics in the smartphone industry

Barros, Mário; Dimla, Eric

DOI (link to publication from Publisher):
10.31880/10344/10164

Creative Commons License
Unspecified

Publication date:
2021

Document Version
Publisher's PDF, also known as Version of record

Link to publication from Aalborg University

Citation for published version (APA):
Barros, M., & Dimla, E. (2021). *Stepping out of Planned Obsolescence into the Circular Economy: the emergence, effects, and ethics in the smartphone industry*. Paper presented at 4th Conference on Product Lifetimes and the Environment (PLATE), Limerick, Ireland. https://doi.org/10.31880/10344/10164

4th PLATE 2021 Virtual Conference
Limerick, Ireland - 26-28 May 2021

Stepping out of Planned Obsolescence into the Circular Economy: the emergence, effects, and ethics in the smartphone industry

Mário Barros[a], Eric Dimla[b]
a) Aalborg University, Aalborg, Denmark
b) Vietnamese-German University, Thu Dau Mot City, Vietnam

Keywords: Planned obsolescence; Industrial design; Smartphones; Product lifetime; Modularity.

Abstract: A constructive debate on the circular economy entails rethinking planned obsolescence. The increased production and use of consumer electronics, together with their high replacement rate substantially increases electronic waste.
Planned obsolescence consist of multiple strategies for rendering a product obsolete. In recent years, we have observed a shift from aesthetic obsolescence to technological obsolescence in for example, smartphones. As regards hardware, the life span of a product is artificially reduced by designing components that cannot be disassembled without damaging the product. Software obsolescence, on the other hand, comprises updates that slow down devices, or create incompatibility between operating systems and running applications.
This paper investigates these practices in the smartphone industry. Based on the analysis of the literature we compare planned obsolescence strategies adopted by major companies against circular economy strategies and policies recently implemented. We assess the embodiment of the strategies by analysing product features and indexes of repairability in smartphones and characterise technological obsolescence considering hardware, firmware and software.
Our conclusions suggest that tackling planned obsolescence requires policymaking that establishes guidelines for reliability to strengthen indexes of repairability as information to consumers.

Introduction

Planned obsolescence (PO) and circular economy (CE) are contrasting product life strategies.
PO is when the life cycle of a product is shortened by design (Packard, 2011). In the field of consumer electronics, PO aggravates the linear economy process characterised by the exploration of natural resources at the beginning and the generation of e-waste at the end of it. The amount of e-waste is increasing, and less than 18% of it was collected and recycled in 2019 (Forti et al., 2020). PO's waste problem, the lack of policies to counteract it and the need for extended producer responsibility has been outlined (King et al., 2006).
The CE methodology (Webster et al., 2017) approaches these issues from a systemic standpoint, recognising that products must be designed to last longer and business models must include repairing, reusing, remanufacturing, and recycling as interconnected tiers of circularity.
In order to make the transition from a linear economy to a more circular economy, new business models and product design methods have to be defined (Bocken et al., 2016). Regarding product design, research has defined guidelines that anticipate the needs of multiple cycles (Go et al., 2015; Sumter et al., 2017, 2020) as well as recommending adequate lifetime extension strategies for electric products (Bakker et al., 2014). There is still no comparative research between the embodiment of PO and CE strategies in products following their potential for repairability.
In this paper, we study the implementation of PO and CE strategies in products, by focusing on industrial design decisions that promote or hinder repairability. Considering repairability as a decisive factor in the implementation of the first tier of circularity and product lifetime extension, we investigate this paradigm in the smartphone industry, as an example in the consumer electronics category. Firstly, we select specific smartphones that epitomise the application of PO and CE strategies within consumer electronics, perfected by companies that have a significant market pull effect.

Secondly, we assess indexes of repairability, establishing links to product architecture and features. Thirdly, we discuss the specific differences of these product life strategies in the larger context thus contributing to the debate of sustainability in the smartphone industry.

Theoretical Background

Planned Obsolescence

PO aims at reducing the lifespan of a product so as to stimulate repeat sales (Packard, 2011). PO comprises three categories: functional, technological and aesthetic. Functional obsolescence is the result of a new product outperforming an existing one. It occurs when there are short innovation cycles, when companies compete on trying to fulfil a need in the best way, or when a single company releases a product in the market while already planning the release of its substitute. Technological obsolescence is when a product stops performing its function due to a faulty or broken component whose life cycle has been reduced by design. Different components often deteriorate at different rates and it is frequently difficult to obtain spare components, with the result that the entire product has to be discarded. In smartphones, software obsolescence (Bartels et al., 2012) needs to be included in the analysis of technological obsolescence. Smartphones can become obsolete if an operating system update renders other software obsolete, or when technical assistance is terminated, or a software update cannot be executed in a certain hardware (Sandborn, 2007).
Aesthetic obsolescence involves the alteration of superficial characteristics of a product to create a new model perceived as more efficient, turning the previous version obsolete despite its primary function still sound (Sloan, 1990).
PO incorporates strategies from both functional, technological and aesthetic obsolescence categories, with the emphasis on each one being dependent on the type of product and industry in which it operates.

The Circular Economy

Even though PO constitutes the main paradigm of production, alternative strategies have been developed over time. The current push towards counteracting such a paradigm can be summarised from two main approaches. A bottom-up approach led by grassroots organisations and international networks of environmental NGOs (Right to Repair, 2020) demanding a more sustainable development. The CE, on the other hand, is a top-down approach that has gained momentum in academia, industry and policymaking levels (Geissdoerfer et al., 2017), by addressing the relationship between environmental resources and the economy and by acknowledging such existence in a closed loop with different tiers.
The EU (European Commission, 2020) has implemented CE principles into policymaking. In France, under the bundle of laws addressing waste reduction and the CE (MTE, 2021), one of the measures encompassing direct information for consumers is the index of repairability (IOR). From the beginning of 2021, five categories of electronic products, amongst which smartphones, must feature an IOR. The French IOR is a 0–10 point system, where 10 accounts for maximum ease of repairability. The manufacturer calculates the IOR based on predefined parameters developed by the French Ministry of Environment.
The first to develop an index of repairability were iFixit (2020) in 2009 and subsequently consulted in the development of the French IOR. In the online platform, users develop repair guides for products in a collaborative and crowdsourced-reviewed way. The score is measured by a 0–10 point system. The main difference between the iFixit IOR and the French IOR is that the former focuses only on the ease of disassembling and repairing steps. The latter encompasses five categories: 1) documentation; 2) disassembly, accessibility, tools and fasteners; 3) availability of spare parts in the market; 4) price information of spare parts; and 5) access to software update, remote assistance and factory reset. There is a similarity between the iFixit IOR and the second category in the French IOR.
General principles for shifting the consumer electronics industry towards the CE have been defined in a report by Meloni et al. (2018). These principles include design decisions about hardware, such as designing products that can be adaptable, repaired and are easily disassembled for recycling. Regarding software obsolescence, it is suggested the design of stable operating systems that last longer and the use of big data to monitor the life cycle of hardware components. The report recommends improving the reuse market, through the optimisation of the connectivity amongst consumers and the automation of supporting processes, such as disassembly, sorting and refurbishment.

Data Collection

Data collection combines secondary data with netnography (Kozinets, 2009).
Data is collected directly from the manufacturers' websites and forums. Data to analyse repairability comes from iFixit repair guides to inquiry about the practical steps of repairing, and infer related industrial design decisions. The data is then cross-referenced with the analysis of the French IOR.

Linking Product Life Strategies to Product Features

Hardware

Table 1 shows the released flagship models of Apple and Samsung and the Fairphone releases in 2019 and 2020, together with their respective IOR.

Year	Model	IOR (0-10)	
		iFixit	France
2019	iPhone 11	6	4.6
	iPhone 11 Pro	6	4.6
	iPhone 11 Pro Max	6	4.5
	Samsung Galaxy S10	3	5.7
	Samsung Galaxy S10e	3	5.7
	Samsung Galaxy S10+	3	5.6
	Samsung Galaxy S10 5G	-	-
	Fairphone 3	10	-
2020	iPhone 12	6	6
	iPhone 12 Pro	6	6
	iPhone 12 Pro Max	6	6
	iPhone SE	6	6.2
	iPhone 12 Mini	6	6
	Samsung Galaxy S20	-	
	Samsung Galaxy S20 5G	-	5.7
	Samsung Galaxy S20 FE	-	8.1
	Samsung Galaxy S20+	-	5.9
	Samsung Galaxy S20 Ultra	3	5.7
	Fairphone 3+	10	8.7

Table 1. Selected smartphones releases and repairability index. Source: iFixit (2020) and MTE (2021)

Not surprising, the Fairphone tops the iFixit IOR scale as the *Fairphone 3* product development encompassed a partnership with iFixit for facilitating repair activities. Furthermore, it builds on independent expert knowledge of life cycle assessment of the previous version of the product (Proske et al., 2016). Regarding repairing alone, the justification for the easiest repair is drawn from modularity being applied to the overall product architecture and down to smaller components. The steps of disassembling and reassembling that constitute the core of the user experience in repairing activities are taken into consideration, with visual cues and labels in the components.
Accessibility for components more prone to substitution is facilitated. As an example, the battery is accessed without tools by removing a snap-fit lid. The Fairphone comes with a fitting screwdriver that enables disassembling the other modules. The length of the screws is the same thus simplifying the reassembling procedure.
Apple disrupted the smartphone market with the iPhone release in 2008, creating a new product typology. The result was rapid sales growth, doubling each year between 2008 and 2012 and peaking at 231 million devices sold in 2015 (Statista, 2018).
Apple released three models in 2019 and five in 2020. In Table 1, it is observable that *iPhone 11* versions released in 2019 score 6 on the iFixit index and below 5 in the French IOR scale.
Design decisions related to the positive score in iFixit are the easy access to the battery and display on the different versions. Nonetheless, there are other decisions that hinder repairability, such as the use of proprietary screws that makes repairing by a third-party more complicated, the use of multiple types of screws, a product architecture with complex sub-assemblies and glued components requiring preheating to be opened. Moreover, the rear glass glued to the chassis cannot be replaced.
In the French IOR, in the category directly related to repairability, there are the following criteria: easy access to components more prone to substitution, required means and joining methods. In the first criterion, the *iPhone 11* scores 0.8 out of 10, with an overall score of 4.3 out of 20 in the category. In the *iPhone 12*, released in 2020, the respective scores are 2.5 out of 10, and 5.9 out of 20 in the category.
Samsung is not too far behind Apple in market share (Yun et al., 2019). It released four models in 2019 and five in 2020 (in the flagship series). Samsung smartphones score low in iFixit and higher in France. In these models, the use of permanent joining methods such as adhesives and soldering over non-permanent methods such as screws is a recurring design principle that hinders repairability. Since an adhesive is used to hold the whole chassis, every repair has to employ heat to soften up the adhesive that may cause heat damage to the inner components. Batteries are glued to the chassis and displays have integrated sensors that

cannot be detached. Accordingly, the components more prone to replacement are not easily accessible, requiring complex operations, such as removing adhesives and extensive disassembly. Positive industrial design decisions relate to modular components requiring one screwdriver to disassembly them. In the French IOR, Samsung models scores vary. The reason is not clear since models share the same design principles but score differently in the ease of disassembly criterion. As an example, the *Galaxy S20* and *S20 Ultra* score 1.7 out of 20, while the *S20 FE* and the *S20+* score 3.3 out of 10. Despite this, all models share the same product architecture and joining methods, thus requiring the same steps to disassemble the battery, for example.

Software and Firmware

The Fairphone software is open source, which means that communities of programmers can update it or develop new functionalities apart from the official releases.

Samsung operating system is Android which is also open source. Nonetheless, issues with proprietary software update slowing down devices has been reported (Gibbs, 2018).

Apple uses firmware to limit the product usability in case of unauthorised repairs. This principle has been applied to batteries, and extended to cameras and displays since 2020. As an example, when an unauthorised battery replacement is done, the firmware prompts error messages, disables the battery capacity reader and functions such as the Face ID reader. Likewise, firmware blocks camera functionality when the camera is replaced.

Software updates for discontinued iPhones are mandatory to enable users' access to functions such as email and web browsing (Apple, 2019). Battery drain issues related with software update (Sun et al., 2019) is another kind of problem pushing obsolescence in iPhones. Furthermore, Apple complements PO with other strategies such as the legal restriction on repair activities. Apple prevents users and independent repair technicians from repairing their products by not making repair manuals publicly available, limiting access to spare components, not enabling Apple-certified independent repairers to own any stock of components, and by taking legal actions against non-Apple-certified repairers (Mikolajczak, 2020).

Discussion

The design of the Fairphone takes into consideration the user experience of self-repair down to the details of including visual communication to address steps of disassembly and reassembly. On the other hand, Apple and Samsung industrial design decisions increase the difficulties of repairing activities. Whilst Apple uses proprietary screws and complex sub-assemblies in all of its products, Samsung opted for permanent joining methods that create a strong barrier for repair from the outset. Such practices fall under the scope of technological obsolescence of hardware since a faulty component can render the whole product obsolete.

Technological obsolescence in smartphones increases the complexity of repairing. Hardware, firmware and software may become interrelated issues under certain conditions. Firmware can halt components' functionality even though the hardware is working well. Software obsolescence may compromise the functionality of applications and batteries.

The inclusion of an IOR in the French legislation may be an entry point towards limiting PO and stepping into CE principles. The future revision of this legislation, in which the IOR will be supplemented with a durability index that accounts for the reliability of the product (MTE, 2020), is a further step towards that goal. Assessing both repairability and reliability can support mitigating PO because it directly considers the product longevity. Nonetheless, analysing PO and CE considering the IOR as decisive metrics remains currently unclear.

As an example, in the French IOR, the *Samsung Galaxy S20 FE* scores 8.1 and the *Fairphone 3+* scores 8.7. A closer analysis of results shows that in the category related to disassembly, accessibility, tools and fasteners, the Samsung scores 7 out of 20 and the Fairphone 20 out of 20. This indicates that access to hardware repairability contributes little to the overall IOR in the legislation.

Conclusions

Current IOR informs consumers of the potential for a smartphone to have an extended lifetime. Nonetheless, there are some limitations. In iFixit, repairability is assessed mainly from a hardware perspective. On the other hand, the French IOR considers it too little in the overall score.

The identified issue of firmware and software obsolescence requires further research to include them as valid criteria in current IORs.
The strategic considerations that the Fairphone encapsulates and principles demanded by community-centred organisations have been included in the French legislation and the European Circular Economy Action Plan. They constitute positive signs towards shifting PO patterns. Likewise, they demonstrate that the mitigation of PO is a policymaking endeavour supported by industrial design knowledge and heuristics, among others.

References

Apple. (2019). Update your iPhone 5 to resume using App Store, iCloud, email, web, and other services. Apple Support. https://support.apple.com/en-us/HT210712
Bakker, C., Wang, F., Huisman, J., & den Hollander, M. (2014). Products that go round: Exploring product life extension through design. Journal of Cleaner Production, 69, 10–16.
Bartels, B., Ermel, U., Pecht, M., & Sandborn, P. (2012). Strategies to the Prediction, Mitigation and Management of Product Obsolescence. John Wiley & Sons, Ltd.
European Commission. (2020). Circular Economy Action Plan: For a cleaner and more competitive Europe (COM/2020/98; p. 28). European Commission. https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1583933814386&uri=COM:2020:98:FIN
Forti, V., Baldé, C. P., Kuehr, R., & Bel, G. (2020). The Global E-waste Monitor 2020: Quantities, flows and the circular economy potential. United Nations University (UNU).
Geissdoerfer, M., Savaget, P., Bocken, N. M. P., & Hultink, E. J. (2017). The Circular Economy – A new sustainability paradigm?
Gibbs, S. (2018, October 24). Apple and Samsung fined for deliberately slowing down phones. The Guardian.https://www.theguardian.com/technology/2018/oct/24/apple-samsung-fined-for-slowing-down-phones
Go, T. F., Wahab, D. A., & Hishamuddin, H. (2015). Multiple generation life-cycles for product sustainability: The way forward. Journal of Cleaner Production, 95, 16–29.
iFixt. (2020). iFixit: The Free Repair Manual. https://www.ifixit.com/
King, A. M., Burgess, S. C., Ijomah, W., & McMahon, C. A. (2006). Reducing waste: Repair, recondition, remanufacture or recycle? Sustainable Development, 14(4), 257–267.
Kozinets, R. (2009). Netnography: Doing Ethnographic Research Online (1st edition). SAGE Publications Ltd.
Meloni, M., Souchet, F., & Sturges, D. (2018). Circular Consumer Electronics: An Initial Exploration. The Ellen MacArthur Foundation. https://www.ellenmacarthurfoundation.org/assets/downloads/Circular-Consumer-Electronics-2704.pdf
Mikolajczak, C. (2020, June 4). Apple crushes one-man repair shop in Norway's Supreme Court, after three-year battle. Right to Repair Europe. https://repair.eu/news/apple-crushes-one-man-repair-shop/
Ministère de la Transition Écologique. (2020). The Anti Waste Law in The Daily Lives of The French People: What does that mean in practice? https://www.ecologie.gouv.fr/sites/default/files/ en_DP%20PJL.pdf
Ministère de la Transition Écologique. (2021). Instructions manual for the calculation of the repairability index of electrical and electronic equipments (p. 16).
Packard, V. (2011). The Waste Makers (Reprint edition). Ig Publishing.
Proske, M., Clemm, C., & Richter, N. (2016). Life Cycle Assessment of the Fairphone 2. Fraunhofer IZM.
Right to Repair. (2020). Right to Repair. Right to Repair Europe. https://repair.eu/
Sandborn, P. (2007). Software Obsolescence: Complicating the Part and Technology Obsolescence Management Problem. IEEE Trans on Components and Packaging Technologies, 30(4), 886–888.
Sloan, A. (1990). My Years with General Motors (Reissue edition). Currency.
Statista. (2018). IPhone sales by year. Statista. https://www.statista.com/statistics/276306/global-apple-iphone-sales-since-fiscal-year-2007/
Sumter, D., Bakker, C. A., & Balkenende, A. R. (2017). The role of product designers in the transition towards the circular economy: A reality check. Plate Product Lifetimes and the Environment 2017.
Sumter, D., de Koning, J. I. J. C., Bakker, C. A., & Balkenende, A. R. (2020). Circular economy competencies for design. Sustainability, 12(4).
Sun, Y., Kong, L., Khan, H. A., & Pecht, M. G. (2019). Li-ion Battery Reliability – A Case Study of the Apple iPhone®. IEEE Access, 7, 71131–71141.
Webster, K., MacArthur, D. E., & Stahel, W. (2017). The Circular Economy: A Wealth of Flows. Ellen MacArthur Foundation Publishing.
Wernink, T., & Strahl, C. (2015). Fairphone: Sustainability from the Inside-Out and Outside-In. In M. D'heur (Ed.), Sustainable Value Chain Management: Delivering Sustainability Through the Core Business (pp. 123–139). Springer International Publishing.
Yun, B.-S., Lee, S.-G., & Aoshima, Y. (2019). An analysis of the trilemma phenomenon for Apple iPhone and Samsung Galaxy. Service Business, 13(4), 779–812.